

ART & VISION

MUSEUM OF VISION



SEEING IN 3-D

CURRICULUM GUIDE




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INTRODUCTION	
About the Exhibit	
How to Use This Notebook	
1 / THE HUMAN VISUAL SYSTEM	6
Parts of the Eye	7
Activities	
Name the Parts of the Eye	8
Draw Your Eye	9
Hole-in-Your-Hand	10
2 / SIZE SCALING	11
Discussion	
A Size Scaling Story	12
Activities	
Exploring Size Scaling	13
Measuring Size Scaling	14
Size Scaling Drawing and Cutouts	15
3 / OVERLAPPING	17
Activities	
Overlapping Collage	18
Still Life Drawing	20
4 / ATMOSPHERIC PERSPECTIVE	21
Activity	
Atmospheric Perspective Painting	22
5 / LINEAR PERSPECTIVE	23
Activities	
Draw Train Tracks in Perspective	24
Test the Rules of Perspective	26
6 / PUTTING IT ALL TOGETHER	28
Activity	
Create an Artwork with 4 Types of Perspective	29
7 / TRICKS WITH PERSPECTIVE	31
Discussion	
Find the Perspective Tricks	33
GLOSSARY	35
BIBLIOGRAPHY	36



INTRODUCTION

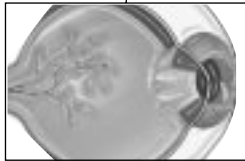
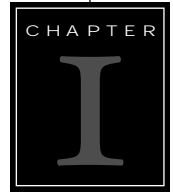
ABOUT THE EXHIBIT



Have you ever wondered how some famous artists create a convincing illusion of depth in their paintings and drawings? For example, a country road or train disappearing into the distance? You might think it's because of a particular artist's outstanding talent, but you would be only partly right. Early in the 15th century, artists developed special visual techniques that helped them create the illusion of depth in the flat surface of their paintings. These techniques—linear perspective, overlapping, atmospheric perspective and size scaling—are explored in the exhibit *Art & Vision: Seeing in 3-D*.

The subjects of art and vision science interconnect at many levels as you will discover in this exhibit. Yet, when we look at art, we're often unconscious of this fascinating interplay that artists and vision scientists have studied for centuries.

continued on next page



THE HUMAN VISUAL SYSTEM

WHAT'S IN THIS CHAPTER?

- Parts of the Eye Key Concept
- Name the Parts of the Eye Activity
 - Draw Your Eye Activity
 - Hole-in-Your-Hand Activity

Two eyes help you see things in depth or in 3-D. However, when you look at the world around you, each eye sees a slightly different view. That's because your eyes are about two inches apart. Your brain combines the two views so you can see things in 3-D. Seeing with two eyes is called binocular vision (*bi* means two, *ocular* means eye.)

Binocular vision is only one way to see 3-D. Your brain also uses clues from the world around you. So even if you don't see with two eyes, you can still see 3-D. Those clues—linear perspective, overlapping, atmospheric perspective and size scaling—are the same clues that artists use to show a 3-D world on a flat surface.

In this chapter, you'll learn about the eye's anatomy and how the human visual system works to help you see in 3-D.

KEY CONCEPT

PARTS OF THE EYE

The iris is the colored part of your eye. It has two muscles that open and close your pupil.

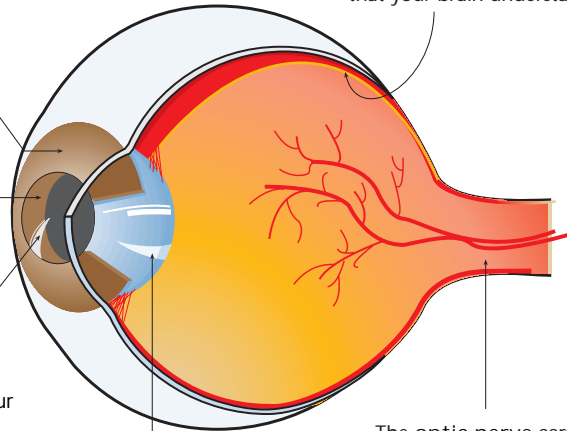
The pupil is the hole in the middle of your iris. It changes size to let more or less light into your eye.

The curved cornea bends light into your eye. It's tough and clear like a windshield and protects your eye from dust.

The lens is clear and flexible. It changes shape to focus light onto your retina.

The retina is the lining inside the back of your eye. Light-sensitive cells on the retina, called rods and cones, change light into messages that your brain understands.

The optic nerve carries the messages from your retina to your brain.

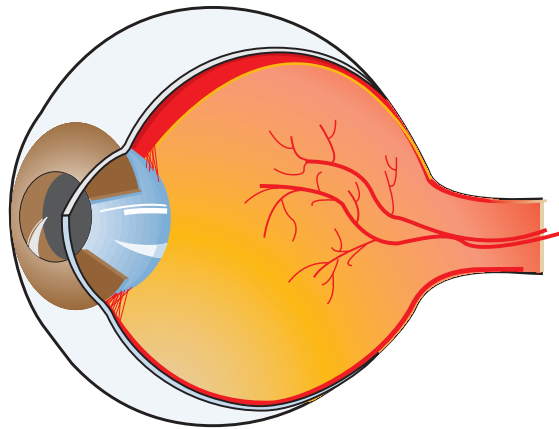


ACTIVITY

NAME THE PARTS OF THE EYE

Can you name the parts of the eye? Color and identify the different parts of this eye cross-section. (Answers on page 6).

Iris
Retina
Lens
Pupil
Cornea
Optic Nerve



THE HUMAN
VISUAL SYSTEM

A C T I V I T Y**D R A W Y O U R E Y E**

Draw a picture of your eye (you might look in a mirror) and include these parts:

Pupil**Iris****Eyelashes****Eyebrow**

THE HUMAN
VISUAL SYSTEM



HOLE-IN-YOUR-HAND

ACTIVITY

TO THE TEACHER

This activity will show you that each of your eyes sees a slightly different view, and that your brain combines the views from each eye to make one image.

- Give each student a cardboard tube, or instruct the student to roll up a piece of paper and make it into a tube.
- Read the following instructions to your students:

MATERIALS

one cardboard tube (paper towel or toilet paper roll works well) OR one piece of paper per student (which the student will roll into a tube.)



TIME

15 minutes

STEPS

Step 1. Hold the tube in your left hand and place it in front of your left eye. (Look through the tube as though you were looking through a telescope.)

Step 2. Keep both eyes open and look at an object in the distance. (You can pick an object in the classroom for the students to look at.)

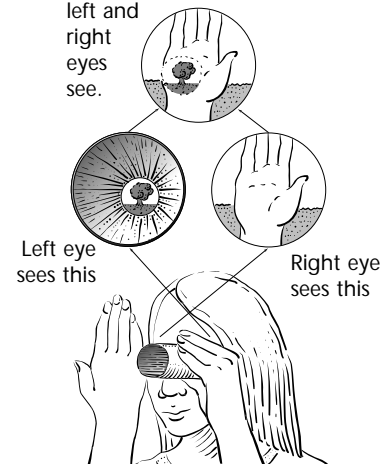
Step 3. Hold your right hand in front of your face, with your palm facing you.

Step 4. Put the edge of your right hand (pinkie finger side) next to or touching the tube, about 4" from your face.

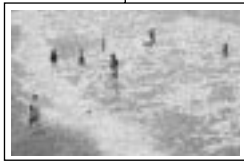
Step 5. Do you see a hole in your hand?



Your brain puts together what your left and right eyes see.



THE HUMAN
VISUAL SYSTEM

CHAPTER
2

SIZE SCALING

When you look at a scene, either a painting or something in the world around you, you notice that nearby objects look bigger than objects that are farther away. For example, a car that's next to you can look much bigger than one that's down the street. You know that the cars haven't actually changed size, they just appear smaller in the distance. Our brains interpret the difference in size to represent distance or depth. This is size scaling. Artists use size scaling to create depth and show distance in their paintings and drawings.

In the activities that follow, you'll play with and explore the concept of size scaling.

WHAT'S IN
THIS CHAPTER?

- A Size Scaling Story Discussion
- Exploring Size Scaling Activity
- Measuring Size Scaling Activity
- Size Scaling Drawing & Cutouts Activity

DISCUSSION

A SIZE SCALING STORY

Each time you look at something new, your brain compares that view with memories of what you've seen before. Your brain uses those memories to help you understand what you're looking at. The story that follows illustrates this point.

READ THIS STORY
TO YOUR STUDENTS

An African tribe lived in the thick forest. Everywhere they looked, they saw trees nearby. The members of the tribe never saw things in the distance—there were always too many trees in the way.



Scientists brought the tribe members to a broad, open plain, something they had never seen before. The tribe members saw a herd of buffalo in the distance. Because they had never seen anything far off in the distance, they thought the buffalo were insects very close to them. Their brains had no memory of seeing anything so far away. When the buffalo moved closer, the tribe members thought the “insects” were growing bigger and bigger and they became frightened. (O’Neil, Catherine. *You Won’t Believe Your Eyes!* p. 34)

Because the tribe members had never seen objects at a great distance, they never developed their size-scaling ability.

DISCUSSION

Discuss this story with your students. Have they ever thought about how their brains might influence what they see? Think about optical illusions.

2
SIZE SCALING

EXPLORING SIZE SCALING

ACTIVITY

Your brain uses size scaling to understand that an object remains the same size, despite changes in distance.

STEPS

step 1. Close one eye.

step 2. Hold your left hand in front of you at arm's length.

step 3. Hold your right hand beside it at half the distance. Both hands look about the same size, right?

What's going on?

When one hand is near and one is far and they are next to each other, they look like they're the same size. That's because your brain knows they are the same size. In fact, the images of your hands on your eye's retina are two different sizes. Your brain overrides the information from your eyes and tells you that your hands are the same size.

step 4. Now move the near hand so it partly covers the far hand. Which hand looks larger now?

When the near hand overlaps the far hand, it actually does look much larger. Your brain concludes that the larger hand is closer to your eyes than the smaller hand. This is called size scaling.

The basic rule of size scaling is that objects in the foreground (closer to the viewer) look bigger than objects in the background (further away from the viewer.) Our brains interpret the difference in sizes to represent distance or depth. Artists use size scaling to create depth and show distance in their paintings and drawings.

MATERIALS
your two hands

TIME
5-10 minutes



2
SIZE SCALING

MEASURING SIZE SCALING

ACTIVITY

DISCUSSION

Take a look at the paintings *Home to Thanksgiving* and *Sailboats Racing on the Delaware* in the exhibit. Can you find examples of size scaling? Can you find places where the artists have shown depth and distance by painting the same subject in different sizes?

STEPS

MATERIALS

magazines, rulers, paper,
pencils, markers
(*National Geographic* or
nature magazines are good
for this activity)

TIME

10-15 minutes



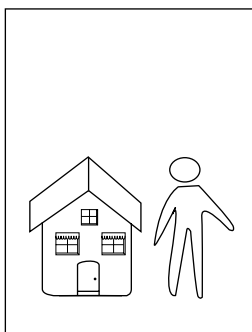
step 1. Take a look through magazines to find pictures that show size scaling. Look for a picture containing two or more of the same thing (say people on a sidewalk or cars on a street or animals in a field). What are your assumptions about the sizes of the objects? Do you think they're all about the same size?

step 2. Use a ruler to measure whatever you selected. Compare the height of the object in the foreground to an object in the distance. What did you discover?

2
SIZE SCALING

SIZE SCALING DRAWING & CUTOUTS

ACTIVITY



STEP 1

MATERIALS

paper, pencil, scissors,
markers or crayons, ruler

TIME

15 minutes



2
SIZE SCALING

STEPS

step 1. On a piece of paper, draw a house and a child that are about the same size (say, about 4" tall).

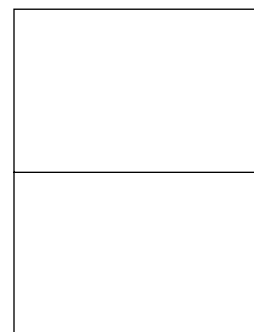
step 2. Cut out both the house and the child.

step 3. Take a second piece of paper and orient it vertically. Draw a horizontal line across the paper about half-way up. This line represents the horizon line—the line between the sky and the earth.

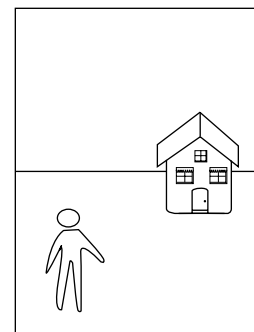
step 4. Place both cut-outs on the second piece of paper. Play around with the positions of the two cut-outs. Place the person in the foreground and the house in the background. Place the house in the foreground and the person in the background.

Which arrangement looks right? Which arrangement of the cutouts creates a sense of depth in the picture?

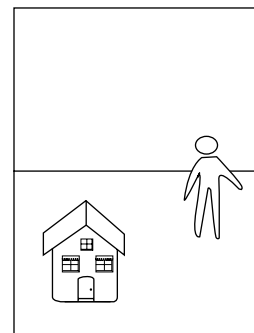
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STEP 3



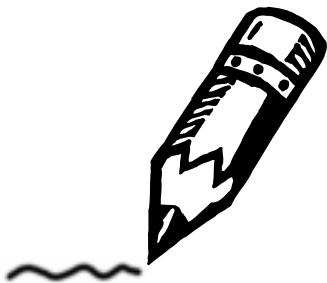
STEP 4



STEP 4

SIZE SCALING DRAWING AND CUTOUTS

continued



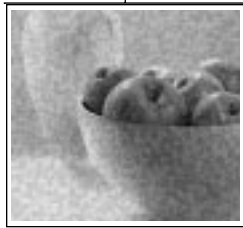
step 5. Now draw a child that's twice the size of the house. Try playing around again with the positions of the house and the child. What do you notice this time? (The house looks even farther away when the child is in front of the house.)

DISCUSSION

Your brain knows that people are usually smaller than houses. So when you see the person in front of the house, your brain thinks the person is close and the house is far away.

But when you see the house in front of the person, it looks strange. Your brain knows that people are not usually bigger than houses, and it can't make sense of this picture.

2
SIZE SCALING

CHAPTER
3

OVERLAPPING

Overlapping tells you where objects are in space: what's in front and what's behind. If you're looking at a bowl of fruit, and a pear blocks part of your view of a peach, your brain tells you that the pear is in front of the peach. Artists use overlapping to tell you where things are in space, and to create a sense of depth in their pictures.

In the activities that follow, you'll create a work of art that shows depth through overlapping.

WHAT'S IN THIS
CHAPTER?

- Overlapping Collage Activity
- Still Life Drawing Activity

OVERLAPPING COLLAGE

ACTIVITY

MATERIALS

magazines, paper, scissors,
glue, pencils, markers

TIME

15–30 minutes



3
OVERLAPPING

DISCUSSION

Take a look at the paintings in the exhibit that illustrate overlapping. Notice that the Japanese woodprint, *Mount Fuji Seen Through a Fishing Net on a Clear Day*, seems quite flat—not much depth is depicted in the scene. But you can tell that certain things are closer (in the foreground) and certain things are farther away (in the background) because of overlapping. How many examples of overlapping can you see in this painting?

STEPS

Collaged scenes often appear very flat, because you're taking bits and pieces out of their original context and pasting them into another picture. But you can indicate depth in your collage by using the technique of overlapping.

step 1. Look through magazines and cut out pictures to make a scene. The scene can be anything: a living room interior, a store, a farm, a still life with fruits, or a group of people sitting around a table. It can even be something fun, like a group of animals sitting around a table.

step 2. Arrange your cut-out pictures and then glue them onto a sheet of paper. Use overlapping to put some of the images in the foreground and some in the background.

continued on next page

OVERLAPPING COLLAGE

continued



step 3. If necessary, draw in missing details with pencil or marker. For example, if you want to arrange things around a table, you might have to draw the table. Or you might have to draw a bowl or basket in which to arrange a still life of fruits and vegetables.

step 4. Share your work with the class. Talk about the scene you created and how it shows depth.

FURTHER EXPLORATION

Look at the cubist paintings of Pablo Picasso and Georges Braques. These artists broke the rules of linear perspective. But in some cases, they still indicated depth using the clue of overlapping.

3
OVERLAPPING



STILL LIFE DRAWING

ACTIVITY

STEPS

step 1. Take a look at the painting, *Still Life with Grapes, Figs and a Copper Kettle*, in the exhibit. Notice how the artist used overlapping in this still life to indicate what objects are in front and what objects are behind. See how many examples of overlapping you can find in the painting.

step 2. Arrange the still life items so that they overlap from all vantage points.

step 3. Have the students draw what they see.

If students are hesitant or lack confidence about drawing, have them focus on the contour or outline of the objects, and the relationship of the shapes and lines. Emphasize that it's not important that an apple look like an apple. The main goal is to draw shapes that overlap.

MATERIALS

still life ingredients
(this can be any collection
of 3-dimensional objects:
fruit, vegetables, crockery,
lunch boxes...), paper,
colored pencils, markers,
crayons

TIME

20–45 minutes



3
OVERLAPPING

CHAPTER
4ATMOSPHERIC
PERSPECTIVE

According to the rules of atmospheric perspective, things look lighter in tone and bluer in color as they recede into the distance. This is because the atmosphere—a mixture of dust and moisture—scatters the rays of light from the sun. Blue light penetrates the atmosphere most easily, making the sky appear blue and giving distant objects a bluish cast.

Things also become blurry and less distinct with distance. While you can make out the individual leaves on a tree that's close to you, the tree becomes a solid mass of green when it's far away.

In the activity that follows, you will create a painting using atmospheric perspective.

WHAT'S IN THIS CHAPTER?

- Atmospheric Perspective Painting Activity

ATMOSPHERIC PERSPECTIVE PAINTING

ACTIVITY

PRE - ACTIVITY

Collect examples of atmospheric perspective: pictures from magazines, reproductions of works of art.

DISCUSSION

Take a look at the painting, *Blue Beauty of the Bradshaw*, in the exhibit. Notice that the hills in the foreground are quite green, and those in the distance become lighter and bluer the farther away they are.

MATERIALS

tempera paints, large art paper, paint brushes, sponges, Q-tips (and other tools for painting that will create different textures) palette for color mixing (foil pie plates work well), color images that show atmospheric perspective

TIME

30 minutes



STEPS

step 1. Choose a photograph or a reproduction of a painting that shows atmospheric perspective.

step 2. Copy that image onto another piece of paper using tempera paints. You might want to make a rough sketch in pencil before you start painting.

step 3. Try to match the colors in the original photograph or painting. Practice mixing the colors of paint to create lighter and lighter blues. (Adding white paint will make lighter shades of blue.)

step 4. Experiment with different techniques (different brushes, sponges, other painting materials) to make shapes less distinct and more fuzzy in the distance.

Note: If students are not confident about their ability to copy exactly what they see, suggest that they reproduce the general shapes of the objects in the photograph or painting, and concentrate instead on accurately representing the changes in color.

4
ATMOSPHERIC
PERSPECTIVE



LINEAR PERSPECTIVE

According to the rules of linear perspective, parallel lines in a picture come together at a vanishing point. (Think of railroad tracks.) Objects along these lines become smaller as they approach the vanishing point. Linear perspective was developed in the 15th century by Renaissance artists and mathematicians who were trying to paint and draw the way we see. They wanted to create the illusion of depth on a flat surface.

In the activities that follow, you will learn about one-point perspective, the simplest form of linear perspective. In one-point perspective, all parallel lines in a picture converge towards one vanishing point.

WHAT'S IN THIS CHAPTER?

- Draw Train Tracks in Perspective
- Test the Rules of Perspective

DRAW TRAIN TRACKS IN PERSPECTIVE

ACTIVITY

MATERIALS

paper, pencil, eraser, ruler,
scissors, markers or crayons

TIME

15–20 minutes



TO THE TEACHER

This activity is divided up into separate parts, with opportunities for discussion at the end of each. Depending on the amount of time available, you can do all of the linear perspective activities or break them up over several sessions.

The thumbnail sketches in this activity are designed to guide you and your students in this activity. You can share them with your students or you can keep them for your own reference.

DISCUSSION

- Take a look at the photograph of train tracks in the exhibit.
- What do you know about railroad tracks? (They're parallel.)
- What does parallel mean? (Lines that are parallel are always the same distance apart. They never intersect.)
- What do you notice about the railroad tracks? (They seem to come together in the distance.)
- How can this be if the lines are parallel? (According to the rules of linear perspective, parallel lines appear to come together in the distance.)
- What do you notice about the railroad ties (the horizontal lines between the railroad tracks?) (They get shorter in the distance.)
- What else happens to the railroad ties? (They seem to get closer together in the distance.)

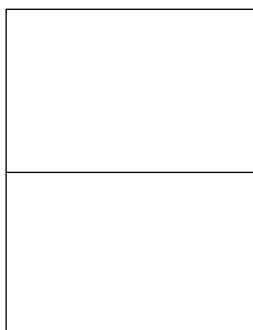
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DRAW TRAIN TRACKS IN PERSPECTIVE

continued

D R A W I N G



STEP 2

step 1. Start with an 8 x 11 piece of paper, oriented vertically.

step 2. Draw a horizontal line across the center of the paper. This is the horizon line—the line between the sky and land.

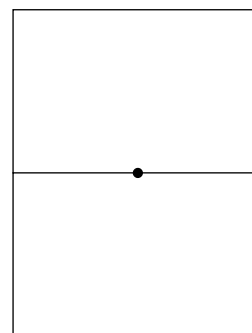
step 3. Make a dot at the middle of the line. This is called the vanishing point.

step 4. Draw two dots at the bottom of the paper, each about 2" from the sides of the paper.

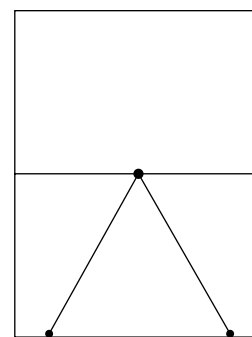
step 5. Use your ruler to connect the dot on the horizon line to the dots at the bottom of the paper with two straight lines. These are your railroad tracks.

step 6. Draw a bunch of horizontal lines between the railroad tracks, making sure they get gradually closer together as they reach the horizon.

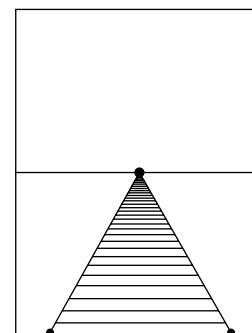
Congratulations! You've drawn railroad tracks using linear perspective.



STEP 3



STEP 4 & 5



STEP 6



TEST THE RULES OF PERSPECTIVE

ACTIVITY

DISCUSSION

- Take a look at the painting, *The Avenue at Middleharnis*, in the exhibit.
- Do you think the trees in the painting are roughly the same size in real life? (Yes, most likely.)
- Why did the artist paint the trees in the foreground so much taller than the ones in the distance? (Trees that are closer to us look larger than trees that are farther away.)
- What would it look like if the artist put small trees in the foreground and large trees in the background? Let's try it and see.

MATERIALS

your drawing of train tracks,
additional paper, pencil,
eraser, ruler, scissors, mark-
ers or crayons

TIME

10–15 minutes



STEPS

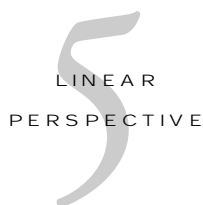
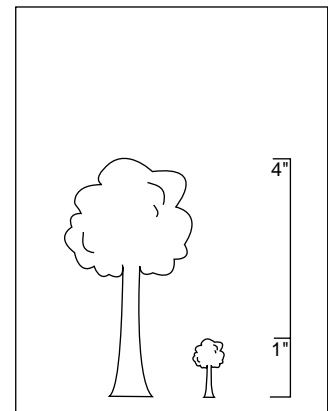
step 1. On a clean piece of paper, draw two trees, one about four inches (4") tall, and one about one inch (1") tall.

step 2. Color in the trees.

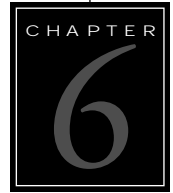
step 3. Cut out the trees.

step 4. Place the trees in different locations along the railroad tracks you drew (page 25, step 6). What happens if you put the small tree

in the foreground and the large tree in the background? What if you place the trees the other way around? What positioning of the trees looks right to your eyes? What doesn't look right?



continued on next page



PUTTING IT ALL TOGETHER

In most cases, artists use more than one form of perspective in their works. They combine atmospheric perspective, linear perspective, overlapping and size scaling to create a work of art that looks like the world we see.

In the following activity, you'll get a chance to combine all four types of perspective into one work of art.

WHAT'S IN THIS CHAPTER?

- Create an Artwork with 4 Types of Perspective Activity

CREATE AN ARTWORK WITH
4 TYPES OF PERSPECTIVE

ACTIVITY

MATERIALS

large art paper, pencils,
erasers, rulers, markers or
crayons, paints, brushes,
palettes

TIME

20-30 minutes



PUTTING
IT ALL
TOGETHER

TO THE TEACHER

In this activity, you'll put the four different rules of perspective—size scaling, overlapping, atmospheric perspective and linear perspective—into one work of art.

You can instruct your students to draw and paint what's described in the instructions below. Or you can encourage them to think of another scene where they can incorporate the four rules of perspective.

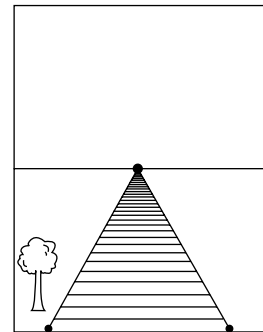
STEPS

step 1. Draw a new set of railroad tracks, or another scene that uses one-point perspective (a road, a field of corn, a hallway, and adapt the instructions that follow to your individual work.)

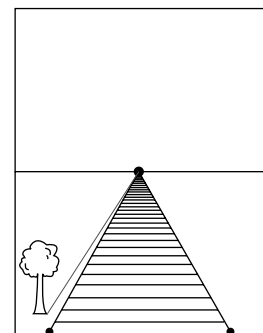
step 2. Draw a tree on one side of your railroad tracks, near the bottom of the page.

step 3. Using a pencil and a ruler, draw a straight line from the bottom of the tree to the vanishing point. This is a reference line—draw it lightly, as you'll want to erase it later.

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STEP 2

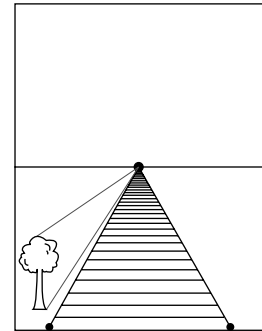


STEP 3

CREATE AN ARTWORK WITH 4 TYPES OF PERSPECTIVE

continued

step 4. Use the ruler and pencil to draw another straight line from the top of the tree to the vanishing point. (If the tree top is above the horizon line, the line will go down to the vanishing point.)



STEP 4

step 5. Now draw more trees along the railroad tracks. Make sure to draw them between the two lines, placing the bottom of the tree at the bottom line and the top of the tree at the top line. Also make sure the trees are straight up and down, perpendicular to the bottom edge of the paper.

This is how artists use one-point perspective to create a sense of depth in their paintings and drawings. Do you notice one of the other rules of perspective here? (Size scaling) Try adding other objects alongside the railroad tracks. What about telephone poles? What about a building?

step 6. Draw mountains in the distance, along the horizon line. Play with the color of the mountains to create atmospheric perspective. How does the color of the mountains change with distance?

step 7. Add other objects to your drawing and use overlapping to indicate what's in the foreground and what's in the background.

6
PUTTING
IT ALL
TOGETHER



TRICKS WITH PERSPECTIVE

Sometimes your eyes play tricks on you. (Think of optical illusions.) And sometimes artists draw things in such a way that you're not sure what you're looking at. In the picture that follows, the artist William Hogarth plays tricks with space and distance. Instead of using the rules of perspective to create a three-dimensional scene, Hogarth deliberately breaks those rules to create a funny picture.

By looking closely at *Perspectival Absurdities*, the print that follows, you might be able to spot some of Hogarth's tricks.

WHAT'S IN THIS
CHAPTER?

- Observation and Discussion:
Find the Perspective Tricks

DISCUSSION

FIND THE PERSPECTIVE TRICKS.

DISCUSSION

In this print, the artist William Hogarth plays tricks on your eye. He has deliberately broken the rules of perspective—overlapping, size scaling, atmospheric perspective and linear perspective—to create a funny image.

Look carefully at the picture to find where Hogarth has broken the rules. Which rules has he broken?

STEPS

step 1. Look at the two men fishing. The pole belonging to the man in the background overlaps the line belonging to the man in the foreground. It should be the other way around. Hogarth broke the rule of overlapping.

step 2. Look at the sign of a crescent moon hanging from the building on the right. The trees in the background overlap the sign. The sign should overlap the trees. Hogarth broke the rule of overlapping.

step 3. Look at the procession of sheep and cows at the lower left corner. The animals get bigger as they get farther away. The animals should get smaller as they get farther away. Hogarth broke the rule of size scaling. Also, the animals in the distance should be more blurry than those in the foreground. He also broke the rule of atmospheric perspective.

continued on next page

7
TRICKS WITH
PERSPECTIVE

FIND THE PERSPECTIVE TRICKS

continued

step 4. Look at the woman hanging out a window in the upper right part of the picture. She holds a candle and appears to be lighting the pipe of a man on a distant hill. The man on the distant hill should be much smaller than the woman lighting his pipe. Hogarth broke the rule of size scaling.

step 5. Look at the square paving in the lower right corner of the picture. The parallel lines of the paving tiles fan out away from each other. They should go towards each other, converging to a single vanishing point. Hogarth broke the rule of linear perspective.

step 6. Look at the row of trees marching up the hill in the center of the picture. The trees appear to get larger in the distance. Notice the size of the bird sitting on top of the largest tree. The trees should get smaller in the distance. Hogarth broke the rule of size scaling. Also the trees in the distance should be more blurry than those in the foreground. He also broke the rule of atmospheric perspective.

step 7. Can you find any other examples of distorted perspective in this print?

7
TRICKS WITH
PERSPECTIVE

GLOSSARY

background

The area of a picture that is farthest away from the viewer.

binocular vision

The effect of seeing using two eyes. The combination of the views from two eyes allows the viewer to see the third dimension—depth.

collage

A technique of making pictures by gluing on paper shapes and other materials that can be cut or torn from different sources.

foreground

The area of a picture that is closest to the viewer.

horizon line

A horizontal line representing the place where the land and the sky meet. It can also represent an imaginary line drawn across the picture plane at the viewer's eye level.

horizontal line

A line parallel to the horizon or to a baseline.
A line parallel to the top and bottom of a paper.

palette

The dish, board or flat slab on which an artist lays out colors to be mixed for painting.

perspective

The drawing method used by artists to show space and distance in a picture, converting a view of the three-dimensional world into a two-dimensional image.

picture plane

An imaginary flat surface, at a right angle to your view, between you and the work you are illustrating.

one-point perspective

A single vanishing point on the horizon line.

still life

An arrangement of non-living objects that forms the subject of a painting or drawing, for example, cups and pitchers, fruits or vegetables.

tempera paint

A paint in which pigment is suspended in a water or egg base. Usually inexpensive, this water-soluble paint is thick and opaque.

three-dimensional

The quality of the real world, which contains open spaces and solid objects that you can move through and around. The three dimensions are height, width and depth.

tone

Color quality or value; a tint or shade of color.

two-dimensional

The quality of a flat surface, such as a paper or canvas. The two dimensions are height and width.

vanishing point

The single point on the horizon where all the lines on the ground level seem to be coming together.

vertical line

A line perpendicular to the horizon. A line parallel to the right and left sides of a page.

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